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This research program is concerned with the general area of the ionospheric plasma utilizing the flight data gathered by the Goddard Space Flight Center. The specific topics of investigations have been selected on the basis of their scientific importance and their mutual interest to NASA and the University of Maryland.

One of the first tasks undertaken in this program was the analysis of a current anomaly observed in the response of a cylindrical Langmuir Probe carried aboard Explorer XVII. We believe that this phenomena is an end-effect which becomes important when the probe axis nears alignment with the velocity vector of the space platform. This problem has been theoretically developed and the results of this study are reported by Bettinger (1966).

Several intriguing possibilities have emerged from this theoretical investigation. Perhaps the most important of these is the possibility of measuring positive ion temperatures from observations of the width of the anomalous peak. It has also been suggested that this effect can be used to define the velocity vector of the satellite with great precision.

Chen (1966) has compared this theory with the Explorer XVII data and finds good agreement.

One of the more intriguing applications of Langmuir Probes to ionospheric plasma research was suggested recently by Brace and Reddy (1965). They examined the ion saturation region of the electrostatic probe

carried aboard Explorer XVII and from its slope estimated the mean mass of the positive ions. Bettinger (1965) calculated the response of this probe to ion mass as a function of orientation on the moving satellite and concluded that it should be possible to determine the relative concentrations of the major ionic constituents from such information. A program is presently underway to compare the experimental results with the theory in order to verify these conclusions. We hope to establish the limitations of the theory, derive and incorporate any changes which seem pertinent, and set up a data analysis program.

Another program presently underway is a comparison between theory and experiment of the volt-ampere characteristics of cylindrical Langmuir probes of the type carried on Explorer XVII and XXII. We are attempting to account for all of the observed phenomena with the view to evaluating the applicability and accuracy of these probes under various conditions. The general agreement between theory and experiment has been found to be quite good with some small but notable variations which are presently under investigation. A by-product of these studies is information on new data analysis techniques which may improve accuracy and perhaps provide additional information.

The interaction of the space vehicle and the ionospheric plasma is one which has received considerable attention over the past several years. It is a complex problem not readily amenable to theoretical analysis. There are several important topics within this general area to which we address our attention.

The sheath surrounding a earth satellite is "manufactured" by eliminating electrons from the plasma vehicle interface for a distance

sufficient to accumulate the appropriate net positive charge to "shield" the vehicle potential. This results from the fact that the vehicle velocity makes the ion rigidity too high to be easily controlled by the potentials normally associated with the satellite. While the potential distribution within this sheath can not "control" the ion motions, it does markedly affect them. This modulation of the ion trajectories by the satellite sheath is of considerable interest with regard to results obtained from ion mass spectrometers carried aboard the satellite. The response of such a detector as a function of the orientation of its aperture relative to the velocity vector of the satellite has a natural width associated with this sheath modulation and simple geometric considerations. Superimposed on top of this "natural width" is a Doppler broadening effect due to the temperature of the ions. Since a large amount of this type of data is available, it would be useful to develop techniques which would permit us to interpret the observations in terms of the ion temperatures.

Brinton (1966) has suggested that the ratio of the signal detected by an ion mass spectrometer with the normal of its aperture parallel and anti-parallel to the velocity vector may also be interpreted in terms of the ion temperature.

Since the translational velocity of the satellite is large compared with the thermal velocity of the ionospheric ions, a wake, which is substantially void of ion, is created by the passage of the satellite vehicle. The electrons, on the other hand, have thermal velocities which are large compared to that of the vehicle; and they tend to fill this wake. Their penetration is limited by charge neutrality considerations.

However, this "electron pressure" will cause the ions to fill the wake at a greater rate than would be predicted by simple diffusion.

A considerable amount of Langmuir Probe data from satellites is available for both electrons and ions. This includes data involving the slow rotation of the probe through various sections of the wake region. We have proposed to analyze this material to obtain an experimental description of the wake and its associated electron "inner sheath". We will attempt to correlate this with theoretical predictions.

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